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Brain Tumor Segmentation based on Outcross Clustering Technique

CH. S. C. Satwick
Department of Computer Science and Engineering
University College of Engineering, JNTU Kakinada
Andhra Pradesh, India

D. Haritha
Department of Computer Science and Engineering
University College of Engineering, JNTU Kakinada
Andhra Pradesh, India

Abstract:-Medical imaging is a process of creating visual representation of the interior of a body for clinical analysis and medical intervention, MRI (Magnetic Resonance Imaging) is a powerful anticipate tool that permits to achieve images of internal anatomy of human-body in a sheltered and non-invasive manner, Brain Tumor is the uncontrolled growth of tissue in any part of the brain which is harmful to human of the complexity involved in brain tumor images. Brain tumor extraction and its analysis is the challenging task in the medical image processing. This paper states image segmentation using efficient K-Means, Fuzzy c-means (outcross clustering) with thresholding and level set methods, The algorithm is designed in such a way that it gives exact tumor segmented images with accuracy and reducing of time for analysis, The stage of the tumor is displayed based on the amount of area calculated from the cluster, The performance evaluation is done on the basis of error percentage compared to growth truth.

Keywords: - Image Segmentation, K-means, Fuzzy c-means, Performance Evaluation

I. INTRODUCTION

Brain Tumor is the aberrant gain of cells inside the brain. The skull, which wraps the brain, is very rigid. Any growth inside such as barred space can cause problems. Brain tumors can be cancerous (malignant) or non-cancerous (benign). When these tumors grow, they can cause the pressure inside which leads to brain damage, and it can be life-threatening. Brain tumors can be classified as primary or secondary. A primary brain tumor arises in your brain, many of them are benign. A secondary brain tumor also known as a metastatic brain tumor, this can be occurred from another organ such as your lung or breast [1]. Therefore medical imaging applications are used to diagnose this tumor.

Medical imaging is the visualization of body parts, tissues, or organs, for use in clinical diagnosis, treatment and disease monitoring. Imaging techniques encompass the fields of radiology. Radiological methods provide the anatomical and physiological detail of the human body at very high spatial and temporal resolution. Images can be enhanced by the use of contrast agents of the methods such as ultrasound, CT, X-ray and MRI [2]. MRI (Magnetic Resonance Image) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body. MRI imaging is often used when treating brain tumors, ankle and foot. From these high resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities. It is more comfortable than CT scan or X-rays for analysis because it doesn’t use any radiation which is harmful to human body so it is based on magnetic field and radio waves [3]. Normally brain tumor causes strokes; here physician treats for the strokes rather than the medication for tumor. So detection of tumor is important for treatment to the person who affected with brain tumor will increase life time if it is detected at current stage [4].

Generally medical images have poor contrast to detect the tumor because of noises or missing diffusive boundaries, so MRI came into existence to diagnose the tumor but still in a meaningful manner to understand the tumor images medical image segmentation plays a healthy role in clinical analysis. Image segmentation refers to process of segregate the image into multiple segments, its main aim is to change the representation of an image into more meaningful and easier to evaluate. Image segmentation is used in order to locate objects and boundaries in images. The result of image segmentation occurs as a set of regions that collectively covers the entire image [5]. Thus there is a need of dynamic medical image segmentation method with some properties of fast computation, accurate and robust segmentation results.

Image segmentation is based on a technique which divides the image into different regions based on image intensity values: discontinuity and similarity, in the explicit manner segmentation of image based on intensity in discontinuity based segmentation includes methods like edge detection that segments an image by detecting the edges or pixels between dissimilar regions that have curt variation in intensity, these techniques do not require any preceding information about the image content and it is faster in computation when compared to others[6]. The other segmentation based similarity states that the image is partitioned to regions which are based on similar depending on a set of reformulate criteria, these includes the methods like region growing, unsupervised, and thresholidng. Region growing states as simple with higher noise immunity than edge detection method, generally it is used to partition an image into regions that have similar properties according to some predefined criteria. Thresholding based segmentation is easy and adequate technique but some preceding knowledge is required about image. Un-supervised classification algorithm is efficient and less error sensitive, such as k-means, hierarchical clustering, self organizing map (SOM), normalized cut algorithm, fuzzy c-means and so on [7].

Clustering is an unsupervised learning algorithm which identifies a finite set of class known as clusters which classify the patterns in such a way that samples of the same group are more similar to one another than samples of different groups, clustering the image means grouping the pixels according to some characteristics. This can be classified as hard clustering, data elements belong to one cluster only and the value of membership of belongingness to a cluster is exactly one. In soft clustering, data elements belong to more than one cluster, and the value of membership of belongingness to a cluster range from 0 to1 [8].

K-means is one of the unsupervised learning algorithms for clusters and it is a type of hard clustering, generally it initially takes K-number of clusters in which centers are chosen randomly, the distance is calculated between pixels and centers. Each cluster has a leader called 'centroid'. Cluster centroids are initialized with random values. The sum of squares of distance between observation and cluster centroid is minimized iteratively. Centroid is then recalculated until convergence. Fuzzy C-means is soft clustering in a way to process the data by giving the partial membership value to each pixel in the image membership value of the fuzzy sets which ranges from 0 to 1. These are formed according to the distance between points and cluster centers which are formed for each cluster. The method has better relevancy to segmentation applications than hard clustering. The algorithm finds its clusters by minimizing its objective function [9]. The image segmentation techniques which were based on clustering were used to detect the tumor in the brain, there are algorithms designed to get the exact tumor image which states that integrating the both clusters to get benefited from accuracy and execution time, After this stage without user interaction the extraction of tumor is done inevitably with thresholding and level set methods to contour the tumor area. This paper is organized in sections as section-2 resides as Literature survey, section-3 states the methodology , and section -4 states as results, Section-5 resides—conclusion, section-6 states Refrenceses.

II. LITERATURE SURVEY

Medical image segmentation is considered as a hot research topic. Several researchers have suggested various methodologies and algorithms for image segmentation. For example, Bandhyopadhyay and Paul [10] proposed a brain tumor segmentation method based on K-means clustering technique. The extraction of the brain tumor region from the processed image requires the segmentation of the brain MRI images to two segments. One segment contains the normal brain cells consisting of Grey Matter (GM), White Matter (WM), and the Cerebral Spinal Fluid (CSF). The second segment contains the tumor cells of the brain. The image fusion method gave a good result in fusing multiple images. In particular cases, it resulted in the loss of intensity. Moreover, it also ignored the finer anatomic details, such as twists and turns in the boundary of the tumor or overlapping region of gray and white matters in the brain. Meena and Raja [11] proposed an approach of Spatial Fuzzy C-means (PET-SFCM) clustering algorithm on Positron Emission Tomography (PET) scan image datasets. The algorithm is joining the spatial neighborhood information with classical FCM and updating the objective function of each cluster. They calculated the weighting function based on these statistics and applied into the membership function. Their algorithm is tested on data collection of patients with Alzheimer's disease. They did not calculate objective based quality assessment that could analyze images and did not report their quality without human involvement. Glavan and Holban [12] proposed system that using a convolution neural network (CNN) as pixel classifier for the segmentation process of some X-ray images. The system analyzes each pixel from the image and tries to classify them into two classes: bone and non-bone. Their CNN obtained the best results in contrast to other configurations. Their method recognized the significant bone areas, but the problems appeared when the bone area presented irregularities and take more execution time in training.Tatiraju and Mehta [13] introduced image segmentation using K-means clustering, Expectation Maximization (EM), and Normalized Cuts (NC). They analyzed the two former unsupervised learning algorithms and compared them with a graph-based algorithm, the Normalized Cut algorithm. many clusters appear in the images at discrete places. The NCuts algorithm gave good results for larger value of *k*, but it takes a long time. M.A. Jaffar et al [14] . In Thresholding and morphological operations the algorithm involved is less complex and easy to understand and implement compared to other techniques.

III. METHODOLOGY

Some of the image segmentation methods for detecting the tumor by using k-means, Here it show the tumor images are fast and can run on large data sets but it fails in giving the incomplete detection of tumor, whereas in the fuzzy c-means algorithm it contains more information of the original image to detect tumor cells accurately compared to k-means, These are sensitive to noise, and aberration it takes long execution time, From this we get aided of these two algorithms. The proposed medical image segmentation consists of 4 stages they are Preprocessing, Clustering, Extracting and Contouring, Validation

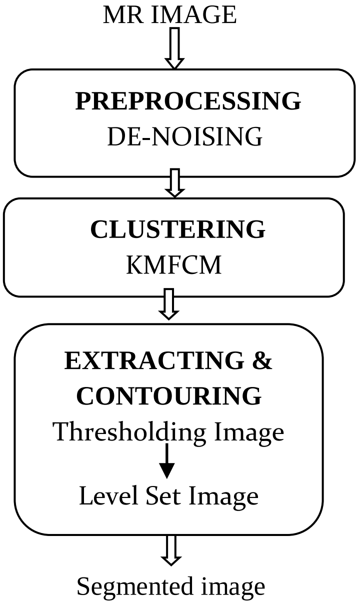


Fig.1. Methodology

A. PREPROCESSING

This stage is implemented by applying some preprocessing procedures to filter the image from noises and improve the quality of the image, Since brain tumor are more delicate than other medical images; they should be merest noise and best quality. Therefore it consists of different disturbances caused by Gaussian and Poisson noise, to eradicate these noises many algorithms came into existence but here the algorithm used is median filter [15]. Median filter is a nonlinear method used to remove noise from images. It is very efficacious at removing noise while conserving edges. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image to pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value [16]. The output of this image can be free noising MR Image (DE-NOISING). Figure-2 shows the output of the image, after applying the preprocessing for the brain MRI image.

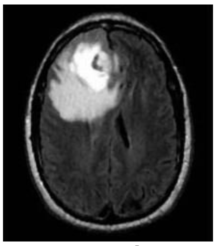


Fig 2. Preprocessed Image

B. CLUSTERING

Clustering can be considered the most important unsupervised learning problem so, as every other problem of this kind, it deals with finding a structure in a collection of unlabeled data[17]. These states that the process of organizing objects into groups whose members are similar in some way. A cluster is therefore a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. So, the goal of clustering is to determine the intrinsic grouping in a set of unlabeled data. It also can be grouping of pixels according to some characteristics such as intensity.

1) *K-MEANS CLUSTERING*:- K-means developed by MacQueen, 1967 is one of the simplest unsupervised learning algorithms that solve the well known clustering problem [18]. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupie is done. At this point we need to re-calculate k new centroids as bar centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more.
Finally, this algorithm aims at minimizing an objective function, in this case a squared error function. The objective function.

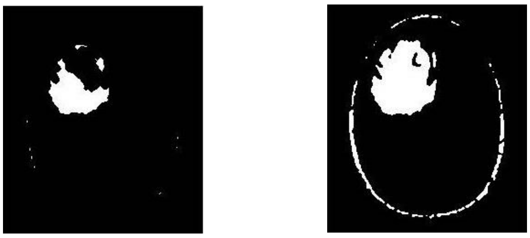
$$J=\sum_{j=1}^{k}\sum_{i=1}^{x}\left\|x_i{}^{j}-c_j\right\|^2 \qquad (1)$$

where $\left\|x_i{}^{j}-c_j\right\|^2$ is a chosen distance measure between a data point $x_i{}^{(j)}$ and the cluster centre c_j, is an indicator of the distance of the n data points from their respective cluster centers.

2) *FUZZY C-MEANS CLUSTERING*:- Fuzzy C-means clustering was developed by Dunn in_1973 and improved by Bezdek in 1981, it is a soft clustering technique which allows partial belongingness of pixels into different clusters [19]. This partial membership is calculated using membership functions. The sum of all membership degrees for any given data point is equal to 1. This method has better applicability to segmentation applications than hard clustering algorithm. The algorithm finds 'c' clusters by minimizing the objective function given by equation(2).

$$JFCM=\sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik}{}^{q})d^2\,(x_k\,,v_i) \qquad (2)$$

where, x_k = {x1, x2, …, x3} are the data points, n is the number of data items, c represents the number of clusters, the degree of membership of x_k in the ith cluster is represented as u_{ik}, q is the weighting exponent on each fuzzy membership, vi represents the centre of cluster i, $d^2(x_k, v_i)$ is the distance between data point x_k and cluster centre v_i.



(a) (b)

Fig.3. (a) After applying K-Means (b) After applying Fuzzy C-Means

These two clustering algorithms have different approaches in detecting the tumor image with their execution time and accurate results so the proposed algorithm is designed as KMFCM (K-means Mended with Fuzzy C-means).

Assign each point to the nearest cluster center based on a minimum distance by checking the distance between the point and the cluster centers based on this re-compute the new cluster centers. It repeats until some convergence criterion is met. On the other hand, there are some points scattered and far away from any cluster center. Therefore, the resulting new cluster centers, the clustered points, and the scattered points can be entered in the same time to the looping step that calculates the new distances and clustering the points due to membership value. Then, the membership and means values are updated with determining the condition of closing.This looping step takes less number of iterations than the random selection because the initial centers of the clusters were not randomly chosen which saves time and effort. Although, the points were reclustered due to its membership. There is no inference between points in their clusters, because there is no huge change done by the re-clustering process. The output of the technique is the clustering image. The output after apply of KMFCM is shown in Figure 4.

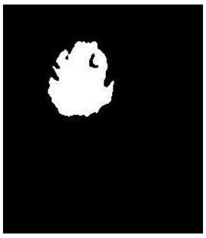


Fig.4. Final Segmented Imge using KMFCM

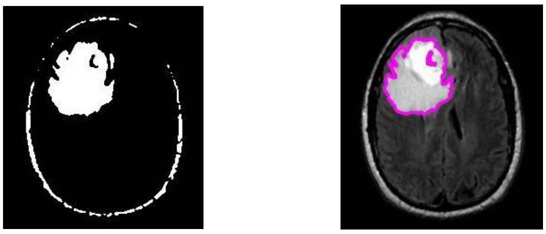
C. EXTRACTION &CONTOURING STAGE:- For the output image, which was obtained by clustering technique, it further process with segmentation methods like thresholding & Level set method

THRESHOLDING EGMENTATION:- In medical image segmentation, thresholding plays an important role as it separate the object from the background using simple intensity value variation, it separate the image into two groups according to threshold value[20] . The segmented image after the thresholding process is done has benefited with smaller storage space, fast processing speed. The threshold of an image is calculated by using the equation (7). Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels above that threshold to one. If g(x,y) is a threshold version of f(x,y) at some global threshold T, then

$$g(x,y) = 1 \text{ if } f(x,y) > T$$
$$0 \text{ if } f(x, y) < T \qquad (7)$$

The output of this step is the segmented image with dark background and lighting tumor area.

ACTIVE CONTOUR BY LEVEL-SET METHOD:- Active contours have been used for image segmentation and boundary tracking since the first introduction of snakes by Kass .[21]. The basic idea is to start with initial boundary shapes represented in a form of closed curves, i.e. contours, and iteratively modify them by applying shrink/expansion operations according to the constraints. The used active contour method show robust segmentation capabilities in medical images where traditional segmentation methods show poor performance. An advantage of the active contours as an image segmentation method is that they partition an image into sub-regions with continuous boundaries. While the edge detectors based on the threshold or local filtering, it often results in discontinuous boundaries. The use of level set theory has provided more flexibility and convenience in the implementation of active contours. Depending on the implementation scheme, active contours can use various properties used for other segmentation methods such as edges, statistics, and texture[22]. The figure 5 shows the threshold image and level-set image



(a) (b)

Figure 5:- (a) Threshold Image (b) Final Level-set Image

The clustering image enters to the threshold segmentation and then the level set, this contours the tumor area of the thresholding image on the original image. The output of this step is the thresholding image and original free noising image with contouring tumor area as giving the index number for the boundaries to exist in level set method then the final level set image appears with as the boundaries.

IV. RESULTS

The results can be done through GUI whch is used to represet the resultant tumor image in a detailed manner, By pressing the buttons it can display the results of the process which are there in the methodology, it is shown in the Figure 6 as the output GUI which consists of Browse Image whch states that taking input as MR Image from the data-sets, De-noised can be treated as preprocessing in which the resultant can be denoised image, Segmentation consists of K-Means image, Fuzzy C-Means Image, KMFC(K-Means mends with Fuzzy C-Means) , thresholding, intial level set of their output images, Classification states that it shows the comparisions through

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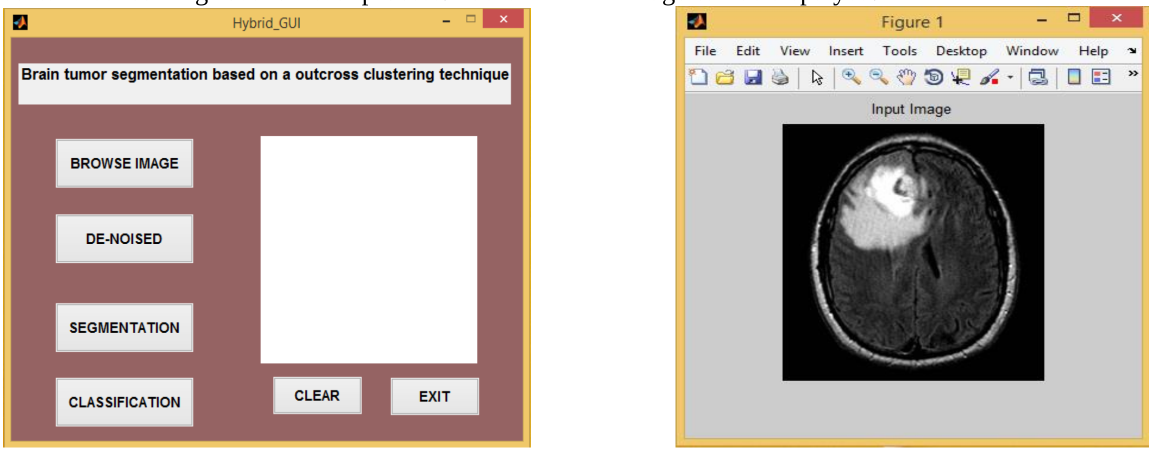
error metris, Clear represents that clearing the MRImages, Exit represents that coming out of the process. Other Figure 6(b) states that after pressing the button resultant image can be dispalyed.



(a) (b)

Figure 6:- (a) Output GUI (b)Resultant Image

The Resultant Images can be taken into the tabular form as Table 1 which represents the final results which leads to finding the tumor in the MRImages.

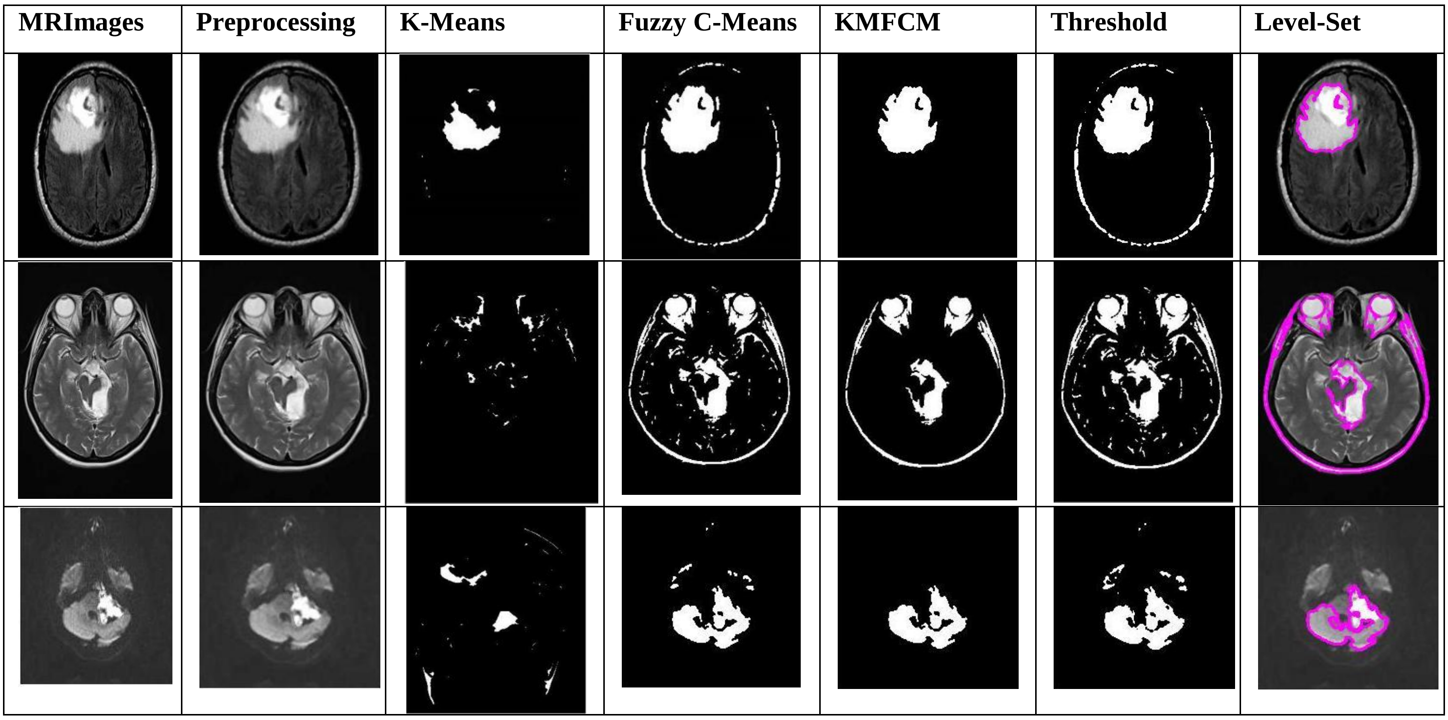


Figure 7:- Output of The Methodology

Finally the performances can be compared with as error metrics of K-Means , Fuzzy C-Means, KMFCM(K-Means Mends with Fuzzy C-Means) by Mean Square Error(MSE) and Peak Signal to Noise Ratio(PSNR). The MSE is cumulative squared error between the compressed and the orginal image, whereas PSNR is a measure of the peak error.

Table 2:- Error Metrices Values

	MSE	PSNR
K-Means	5.234e+03	21.7378
Fuzzy C-Means	1.8205e+03	31.0579
KMFCM	0.7314e+03	19.0639

Based on Table 2 the values of Dataset 1 were taken and found that KMFCM is giving better results compared to K-Means and Fuzzy C-Means

V. CONCLUSION

In the field of medical diagnosis, an extensive diversity of imagig techniques is available presently, such as CT and MRI. MRI is most used for diagnosis than CT on the other hand K-Means algorithm can detect a brain tumor faster than fuzzy c-means, but Fuzzy C-Means can predict tumor cells accuratley. Orginally Fuzzy fails to segment image corruppted by noise, outliers and other imageing artifacts, Therfore developed a new approach that integrates the K-Means, Fuzzy C-Means clustering algorithm to detect brain tumor accuratly in minimum excution time. The segmentation method which includes he thresholding withstands to small storage space, fast processing speed and ease of manipulation and te contouring can be done through boundary tracking algorithms. The experiment results which uses the error metrics as Mean Square Error, Peak-signal noise ratios were calculated and by comparing woth KMFCM the error rates are smaller for MSE and larger values as PSNR for the obtained tumor image.

VI. REFRENCES

[1] Verneda lights, george krucik MD, Racheal Shirley Lin, "Brian tumor, Types, Riskfactors, Symptoms", Diagnoised November 18 2015 http://halthline.com/health/braintumor Accessed on:- August 15th2016
[2] Medical imaging, Radialogy, Vuuniversity Medical Centre(VUMC) Amesterdam,http://vumc.com/branch/imagingcentre/economic-impact/medical-imaging Accesed on september 1st 2016
[3] K umamaheswari, P.Rajesh, S.srinivas Rao, p.Vinodh babu "Application OF Segmnation Methodology for extracting MRI Brain Tumor duly mitigating the Noise" , International Confrenceon computational intelligence and communication Networks, 2015IEEE.
[4] Rohit M.Kabade, SGaikwad MS," Segmntation of Brain tumor and its ara calculation in brain MRI Using K-Means clusetering and Fuzzy C-Mean algorithm". International Journal Computer Science Enginerring Techology(IJCSET) 2015;4(5):- 524-3].
[5] Janani V, Meena P" Image segmentation for tumor detection using fuzzy infrence system". International Journal Computer Sience Mobile Computer(IJCSMC)2013:2(5):244:8
[6] Ratsgarpour M, and Shanbehzandeh J, " Application of AI echniques in Medical image- segmentation and Novel categorization of avaliable Methods and tool"s. Procendys of International Multi Confrence of Engneers and Computer Scientists 2011 Vol1, IMECS 2011, March 16-18 2011, Honkong.
[7] Myat Mon Kyaw, Faculty of Information and Communication Technology, University of Technology(Yatanaron Cybercity), Pyin oo lwin, Mynammar., "Pre- Segmetnation for The Computer Aided Diagnosis System," IJSIT Vol5, no1, Feb-2013.
[8] Piyush M. patel, Brijesh N Shah, Vndana Shah, "Image Segmentation using K-Means Clustering for finding tumor in medical application", International Journa of computer Trends and technology(IJCIT)- volum Issue5- May2013.
[9] Mahesh Yambal, Hitesh Gupta Patel "Image Segmentation using Fuzzy C-Means Clustering" International Journal of advanced Research in computer and communicaion Enginerring vol.2, issue 7, july 2013.
[10] Bandhyopadhyay SK, Paul TU. "Automatic segmentation of brain tumor from multiple images of brain MRI". Int J Appl Innovat Eng Manage (IJAIEM) 2013;2(1):240–8.
[11] Meena A, Raja K. Spatial "Fuzzy C-means PET image segmentation of neurodegenerative disorder spatial Fuzzy C-means PET image segmentation of neurodegenerative disorder". Indian JComput Sci Eng (IJCSE) 2013;4(1):50–5.
[12] Glavan CC, Holban S. "Segmentation of bone structure in X-ray images using convolutional neural network". Adv Electr Comput Eng 2013; 13(1):1–8.
[13] Tatiraju S, Mehta A. "Image Segmentation using k means clustering, EM and normalized cuts" University of California Iryine Technical Report.
[14] Yerpude A, Dubey S." Colour image segmentation usingK-medoids clustering". Int J Comput Technol Appl 2012;3(1):152–4.
[15] Rodrigues I, Sanches J, Dias J," De-noising of Medical images Corrupted by Poission noise in Image Processing", ICIP2008, 15th IEEE international confrence on:2008.p.1756.9
[16] Aucklanduniversity,https://www.cs.aucland.ac.riz/courses/comsci3733lc/patricesLectures/Image%20Filtering_2up.pdf, [accessed 17-9-2.16].
[17] Clustering: An Introduction https://home.deib.polimit.it/mateucc/clustering/tutorial_html/index.html [accessed on 20-9-2016].
[18] Brain T.Luke, "K-means clustering" https://fconyx.ncifcrf.gov/nlukeb/kmeans.html
[19] Malsawn Dawnglana, DaizyDeb, Mousum Handique, SudiptaRous, "Automation Brain Tumor Segmentation in MRI: Hybridized Multilevel Thresholding and Level Set".(SAAC2015).
[20] Deepthi Murthy T.S, G.sadashivappa", Brain tumor Segmentation using Thresolding Morphological Operations and Extraction of feauters of tumor" ICAECG(2014).
[21] Kass M, Witken A, Terzopoulous D.Snakes. active contour model. Int J Comput Vision 1988:1(4):32.3].
[22] Lee CP "Robust image Segmentation using active Aconotur: Level set approach", Pphd thesis, Department of electrical and computer enginerring, North Carlonia State University;2005,p-18-30.